Pavemetrics

Automated Pavement Inspection

Vision Technology for Inspection of Transportation Infrastructures

and Laser FOD Detection System

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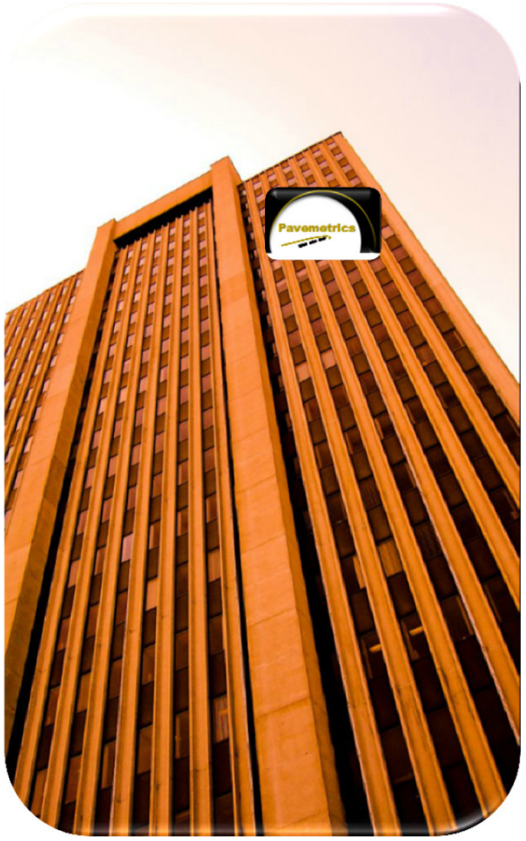
Pavemetrics; Industrial Vision Specialists



Pavemetrics Headquarters
(Banque Nationale Bldg., QC)

- **Founded 2009; a "Spin-off" of Canada's National Optics Institute (INO)**
- **Develop high-speed, mm-level scanning and pattern analysis systems**
- **21,000,000+ Miles of Data Collected Since 1997**
- **200 Systems in 30+ countries**

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Solutions for Roads, Runways, Tunnels and Rail

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40+ Global Integrators and Users in 30+ Countries

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LCMS/LFOD Technology

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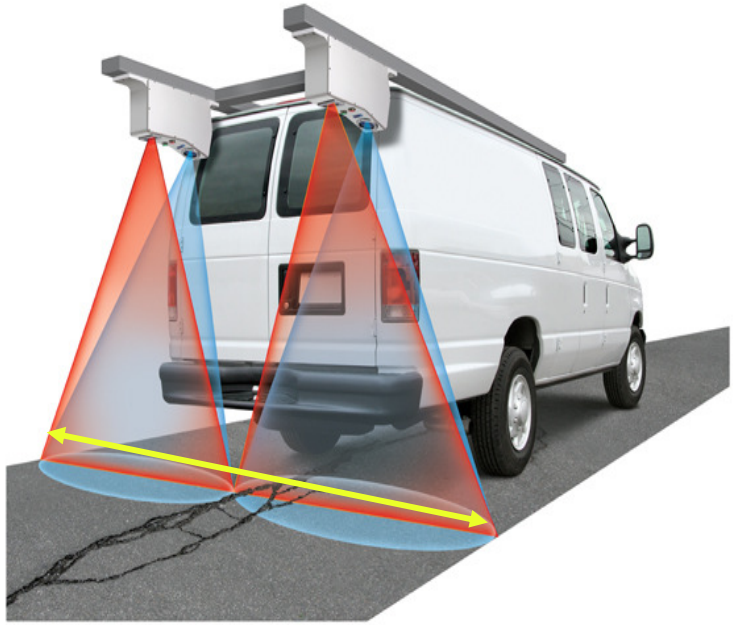
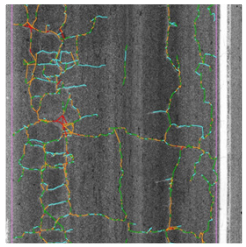
Technology Overview



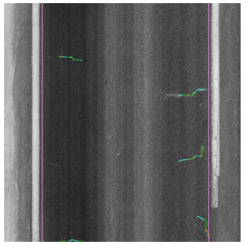
- 2 sensor array that mounts on a vehicle; can be operated at 100km/h
- Adjustable 4-6m width per set, can scale up to 18m width
- Captures a 3D profile and digital image of the road/runway/rail/tunnel/etc.
- Day or night-time operation
- Bundled with pattern recognition software to detect features/defects

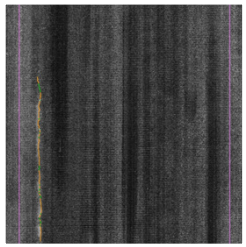
Any Paved Surface



Hotmix

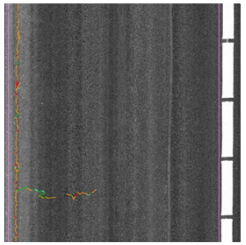
Chipseal



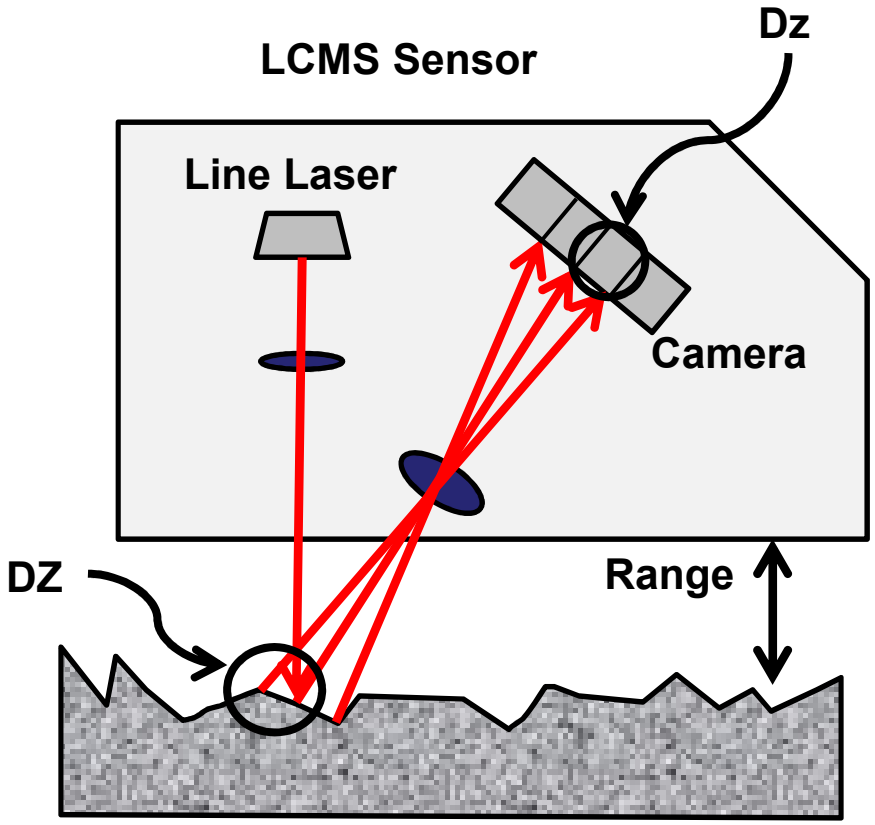


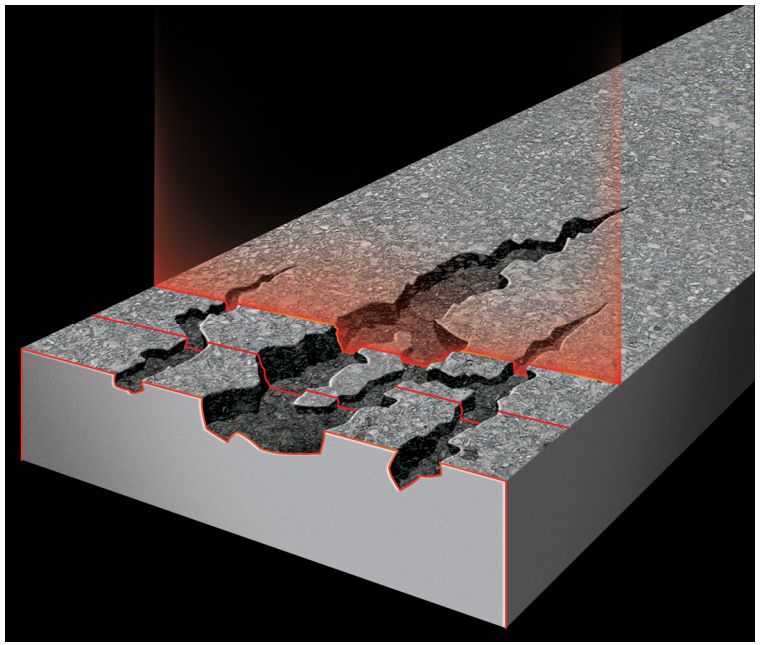
Concrete

Porous



Principle of Operation





Dz = k * DZ;

Where k is a factor for: distance between surface and lens, focal length of lens, refractive index of lens, distance between lens and sensor, etc…

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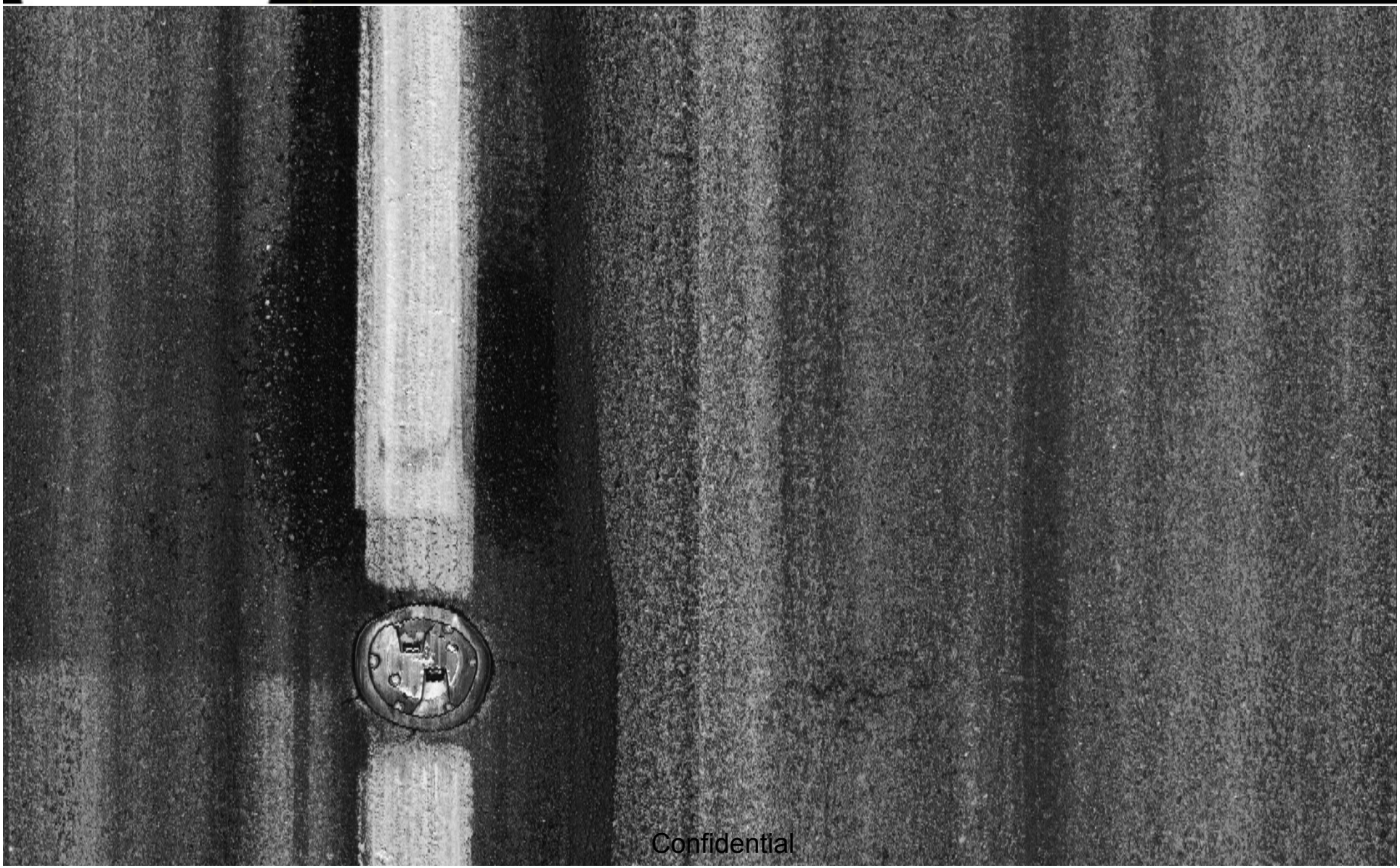
Airport Runway Imaging



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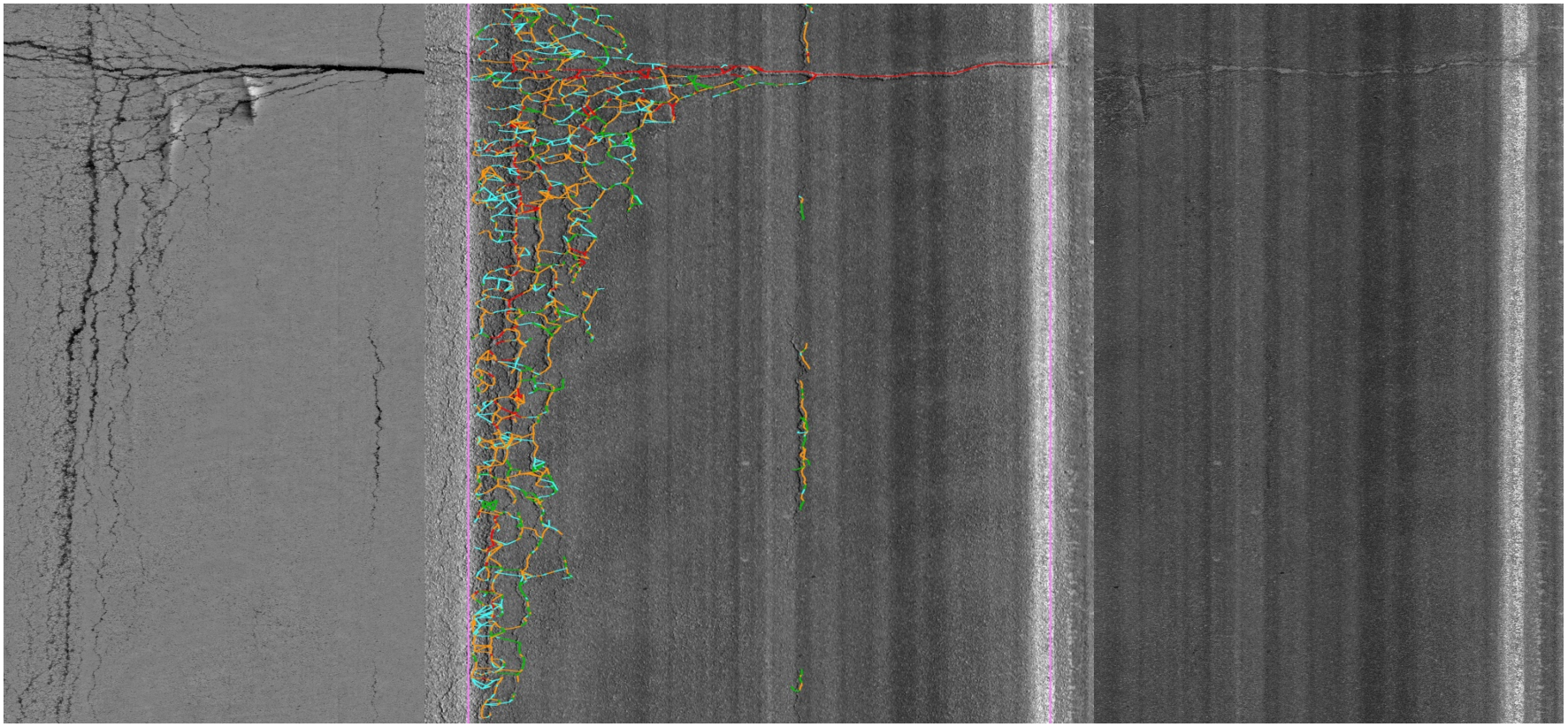
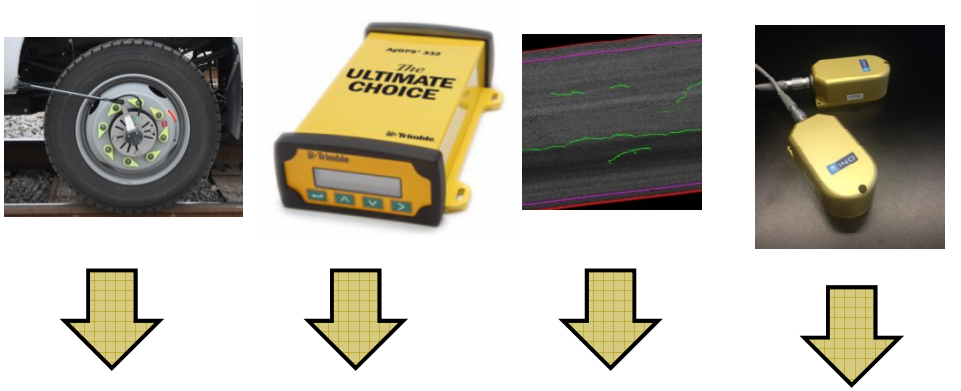
Understanding 3D Imaging

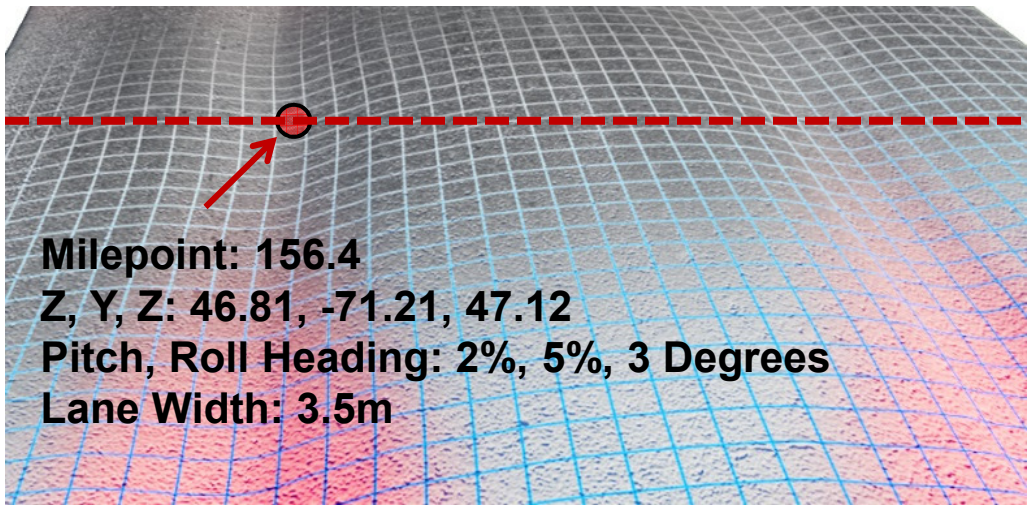


Range **3D** **Intensity**

Location Referencing and Geometry

- Optical encoder (DMI) used to measure linear distance
- GPS tagging of each file
- Stripe & edge detection algorithm
- IMU data





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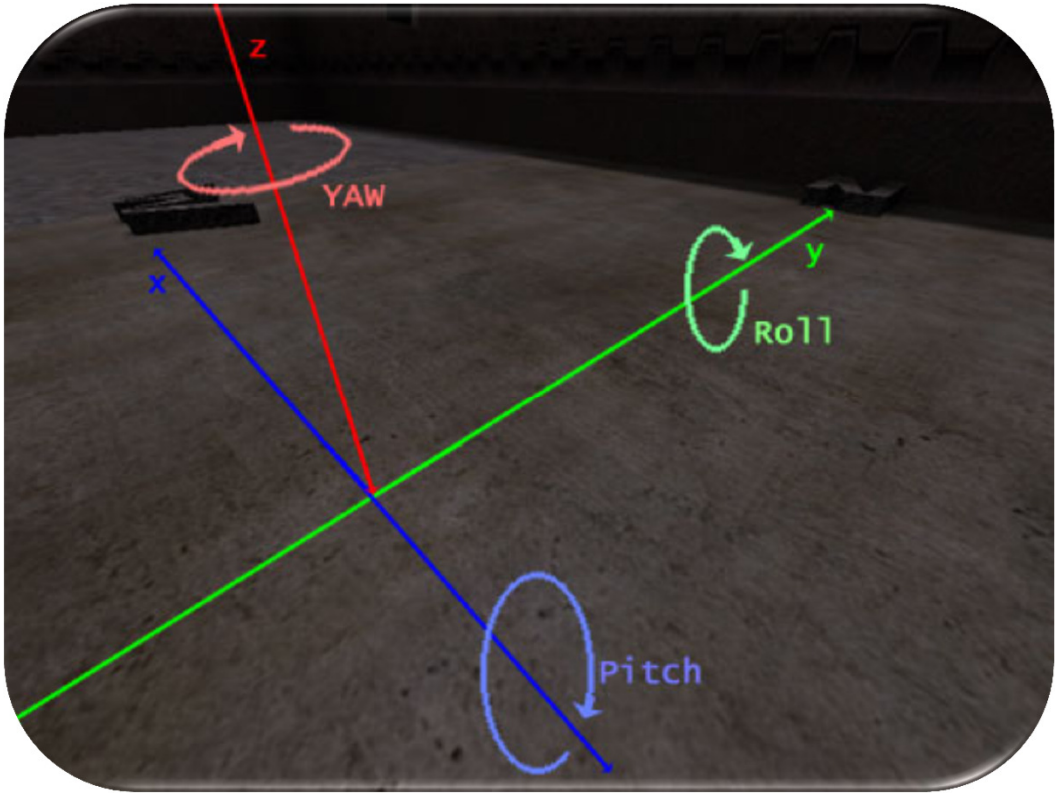
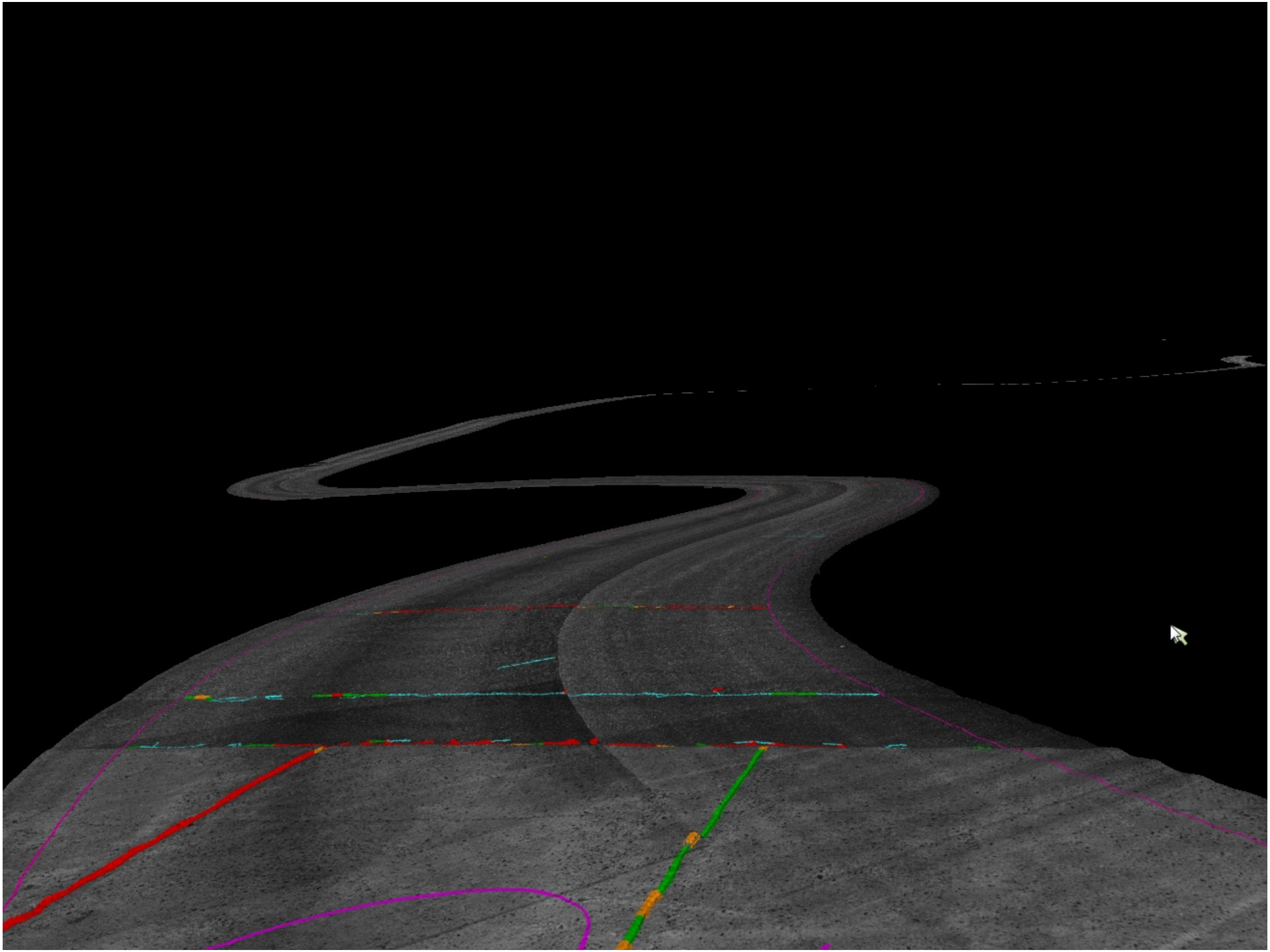
Geometry





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One Sensor; Many Outputs

- Pavement Management
  - Transverse Profile
  - Joint Faulting
  - Sealed cracks
  - Alligator Cracking
  - Transverse Cracks
  - Longitudinal Cracks
  - Bleeding
  - Raveling
  - Potholes
  - Macro Texture
  - IRI
  - Pavement Images
- Inventory
  - Pavement Width
  - Pavement Length
  - Pavement Type
  - GPS Tagging
  - Linear Referencing
- Safety
  - Foreign Object Debris
  - Pavement Markings
  - Horizontal Curvature
  - Cross Fall
  - Longitudinal Grade
- Design
  - Automatic Breaklines
  - Digital Terrain Models

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Data Processing

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Jointed Concrete Pavement (PCC) – PCI Evaluation

Distress Type	Visual inspection with LCMS viewer	Automatic Detection	Automatic classification
Crack	√	√	√
Faulting	√	√	√
Corner Break	√	√	√
Spalling (joint)	√	√	√
Spalling (corner)	√	√	√
Joint Seal Damage	√	√	√
Popouts	√	√	√
Blowup	√	√	
Durability (D) Crack	√	√	
Scaling	√	√	
Shattered Slab	√	√	
Alkali Silica Reaction	√	√	
Shrinkage Cracking	√		
Patching (small and large)	√		
Pumping			

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Asphalt Concrete (AC) – PCI Evaluation

Distress Type	Visual inspection with LFOD viewer	Automatic Detection	Automatic classification
Alligator (Fatigue) cracking	√	√	√
Longitudinal/Transv. cracking	√	√	√
Raveling/Weathering	√	√	√
Rutting	√	√	√
Shoving from PCC	√	√	√
Bleeding	√	√	√
Depression	√	√	√
Block cracking	√	√	
Joint reflection cracking from PCC	√	√	
Slippage cracking	√	√	
Swell-distress	√	√ (if cracks)	
Corrugation	√		
Patching	√		
Jet-Blast Erosion			
Oil-spillage			
Polished aggregate			

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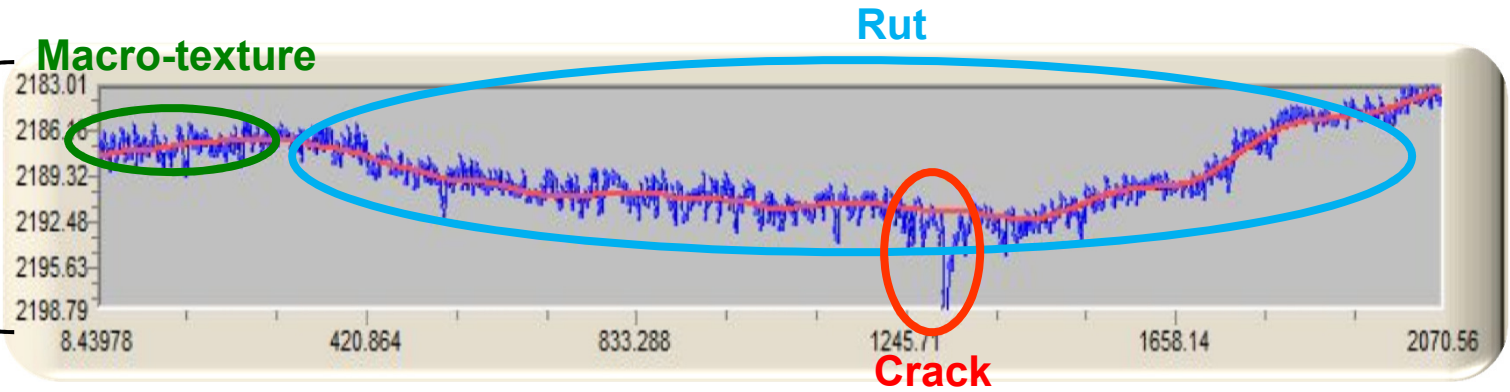
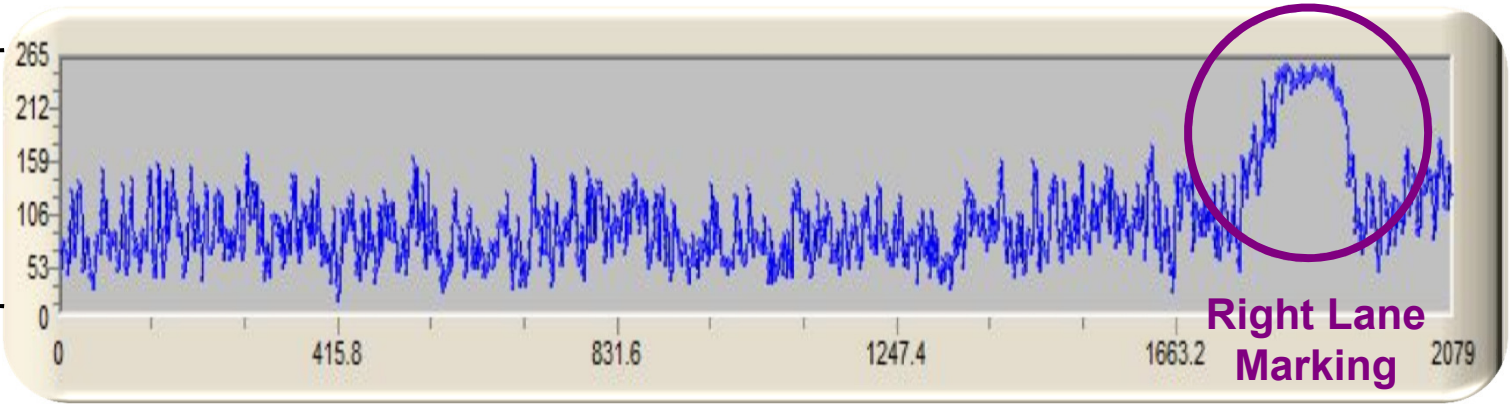
Image and Data Analysis

RANGE
Distance between Sensor and ground (in mm)



INTENSITY
Laser intensity (black = 0, white = 255)



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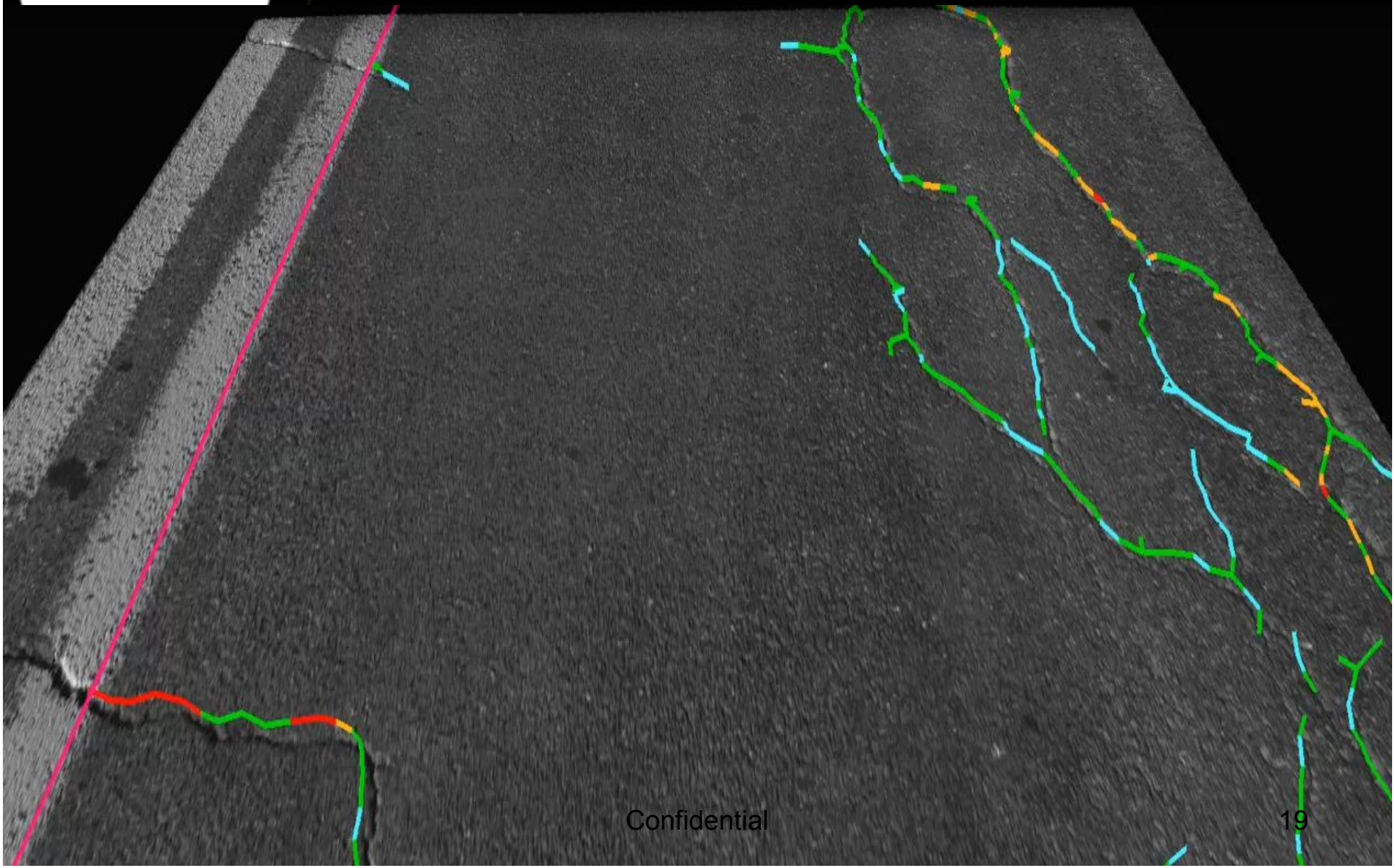
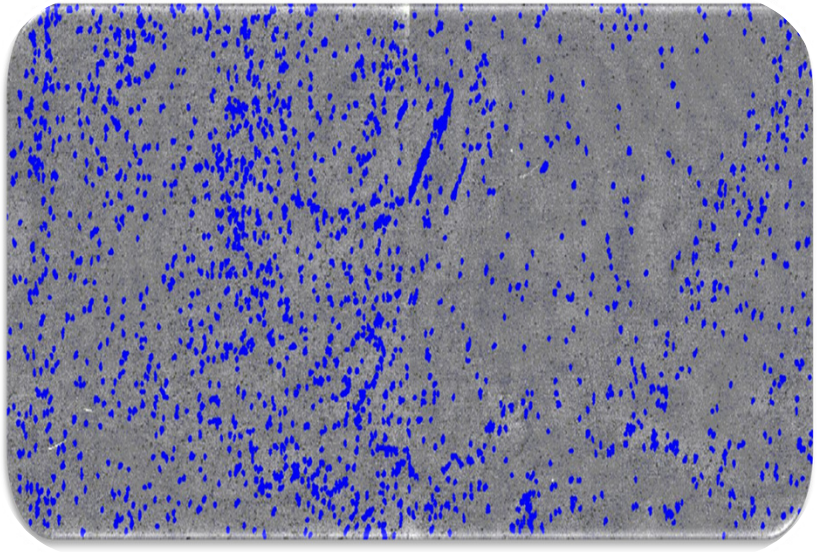
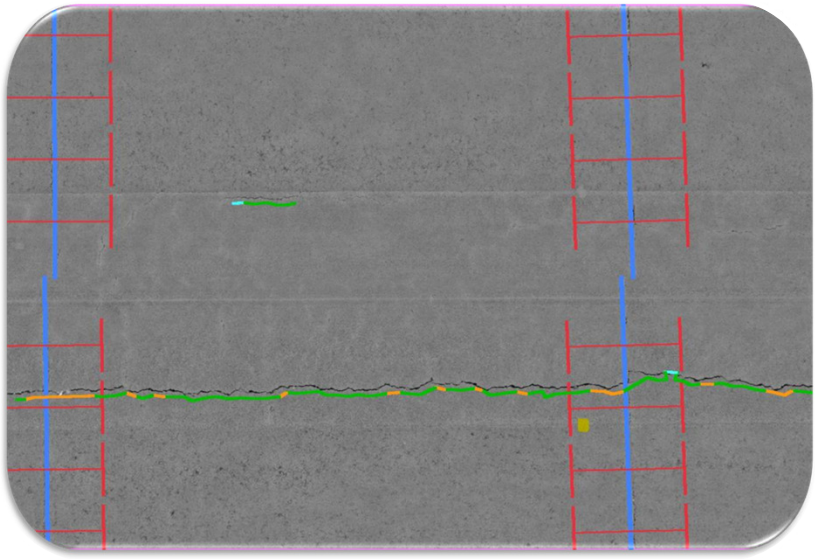
Crack Detection



Pavement Assessment Algorithms

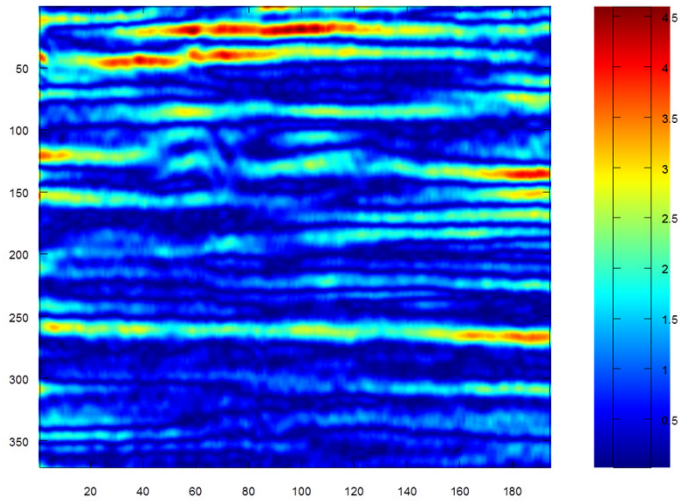


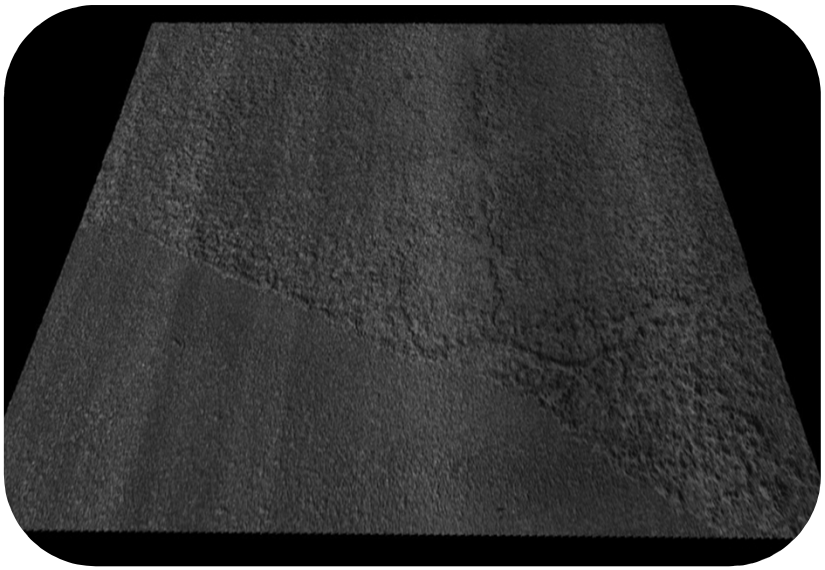
Raveling Detection and Quantification



Joint Detection and Measurement

Pavement Assessment Algorithms

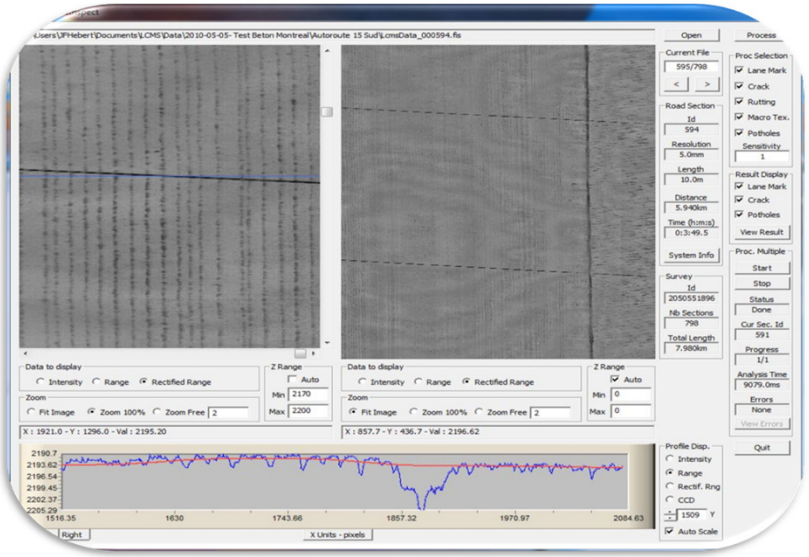




Roughness Mapping

Macrotexture Measurement

Pavement Assessment Algorithms



Bleeding Detection

Grooving Measurement

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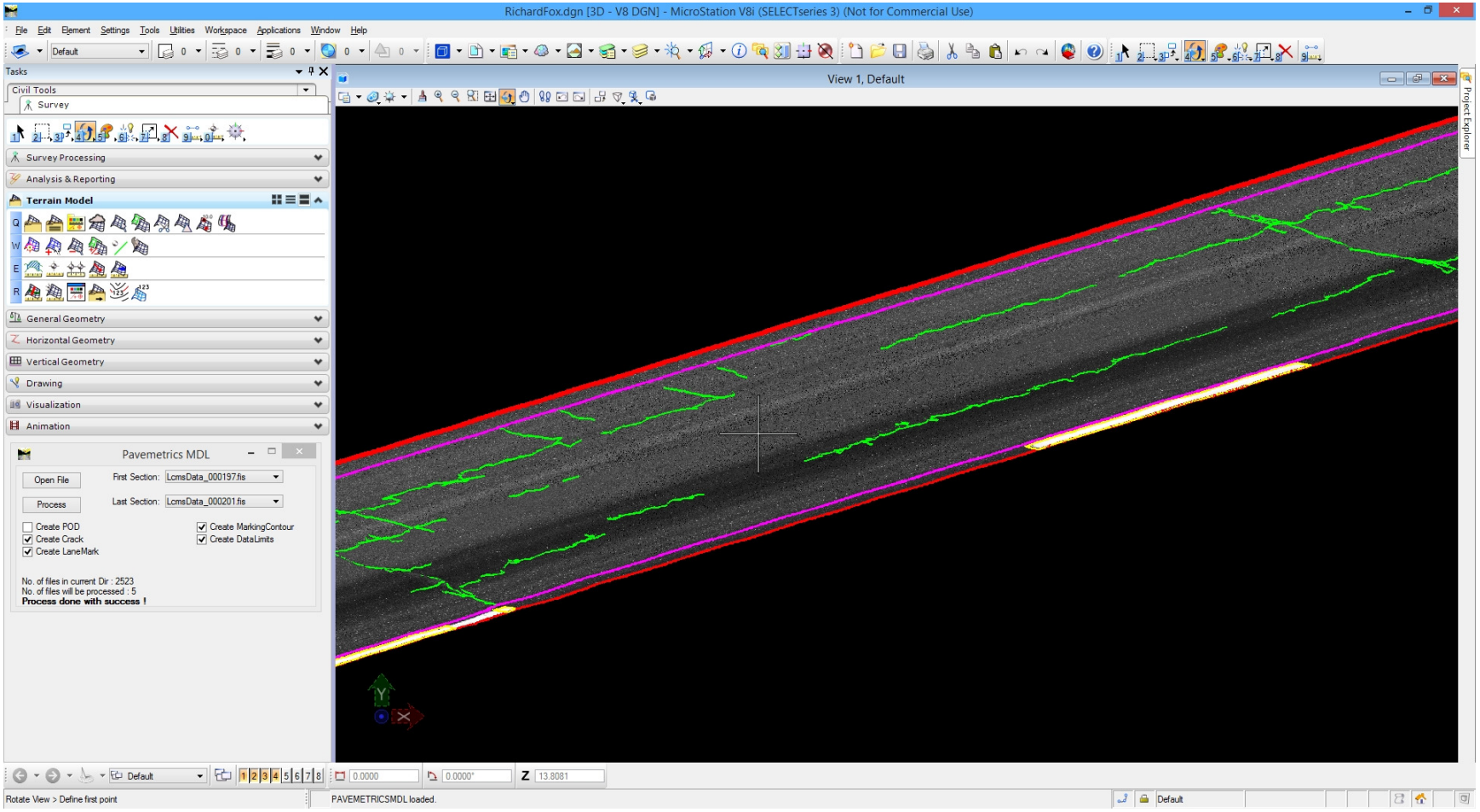
Automatic Generation of DTM Data for Bentley



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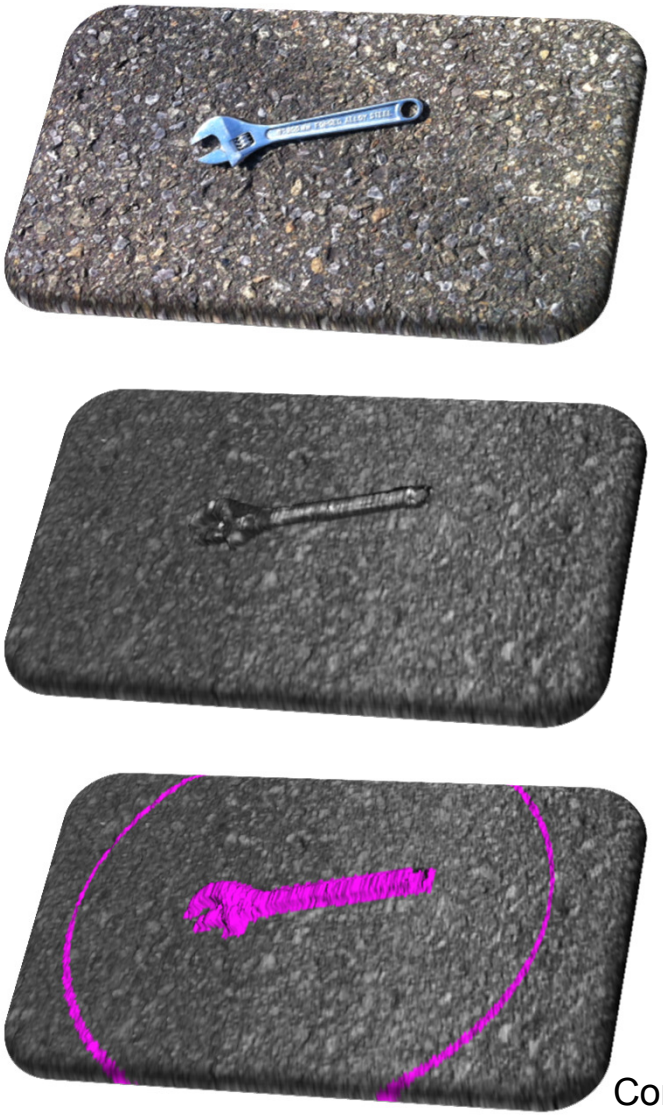
FOD Detection Algorithm



- Algorithm creates a “virtual plane” and detects any 3D shapes which extend above the plane
- Operates in real-time while vehicle drives at 65 mph
- Algorithm reports FOD height, volume, GPS coordinates and an image
- Operational tool to detect FOD as well as a planning tool to help identify FOD “hot-spots”

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Photo of FOD

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LFOD 3D Image

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FOD Algorithm Detects FOD

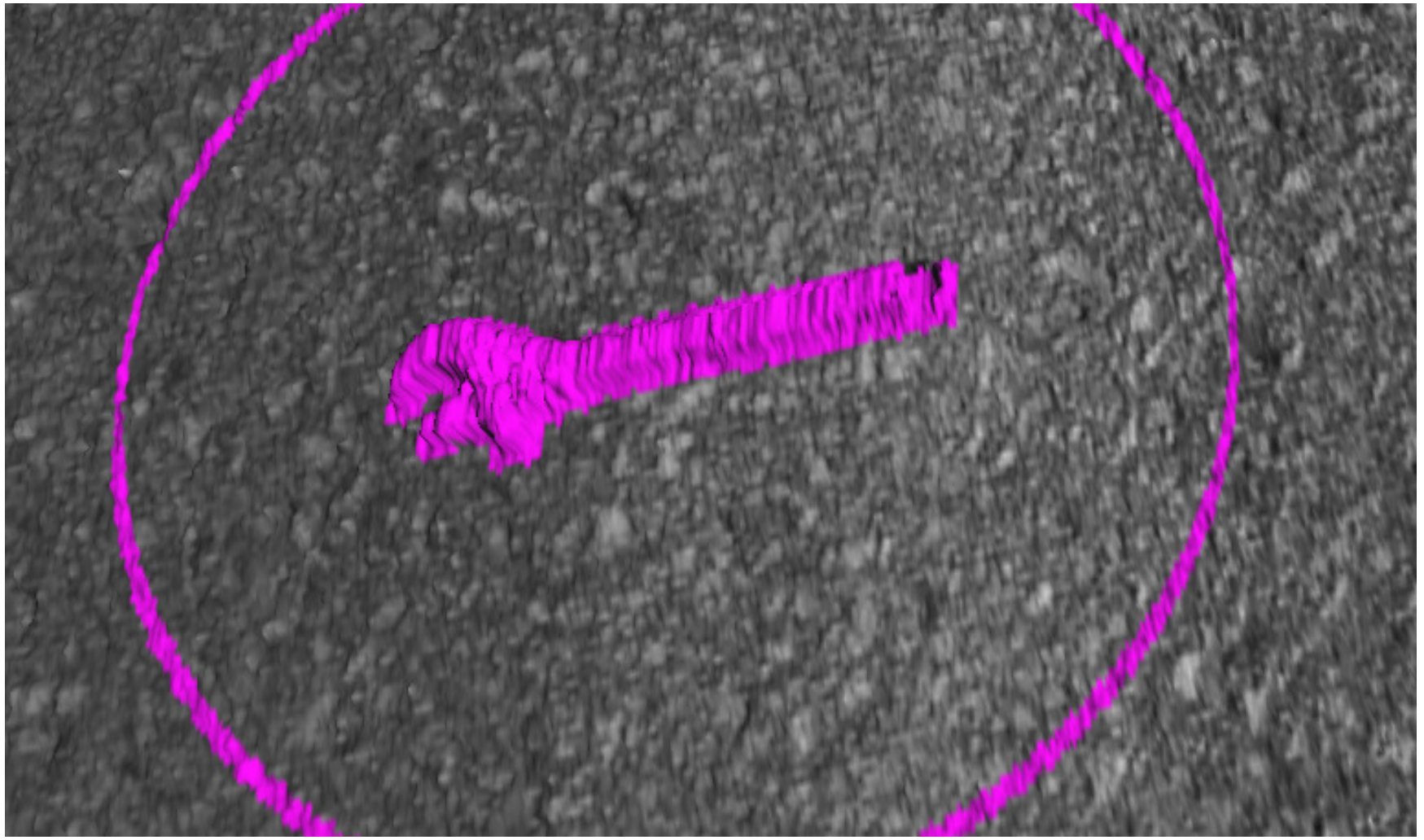
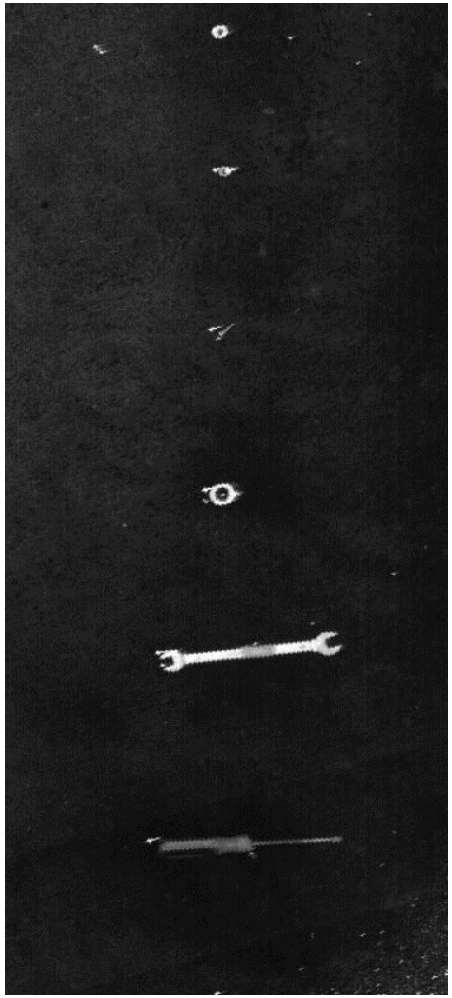


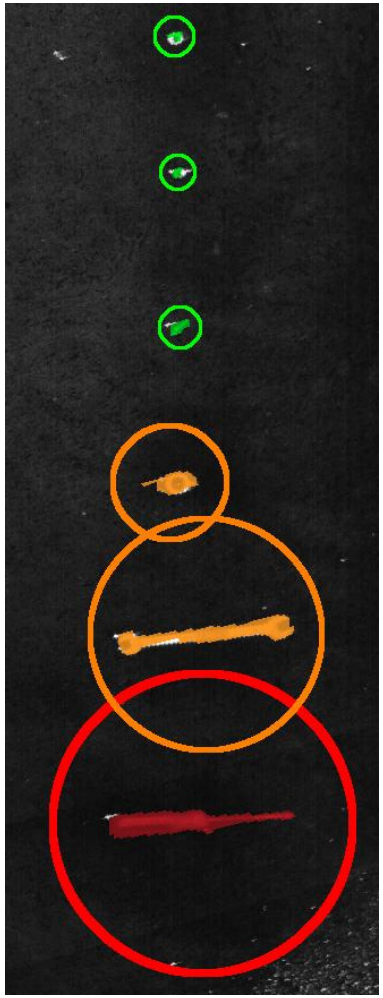
Photo
Submersed FOD, Singapore

Photo
Submersed FOD, Singapore

LFOD Intensity Image of Submersed FOD

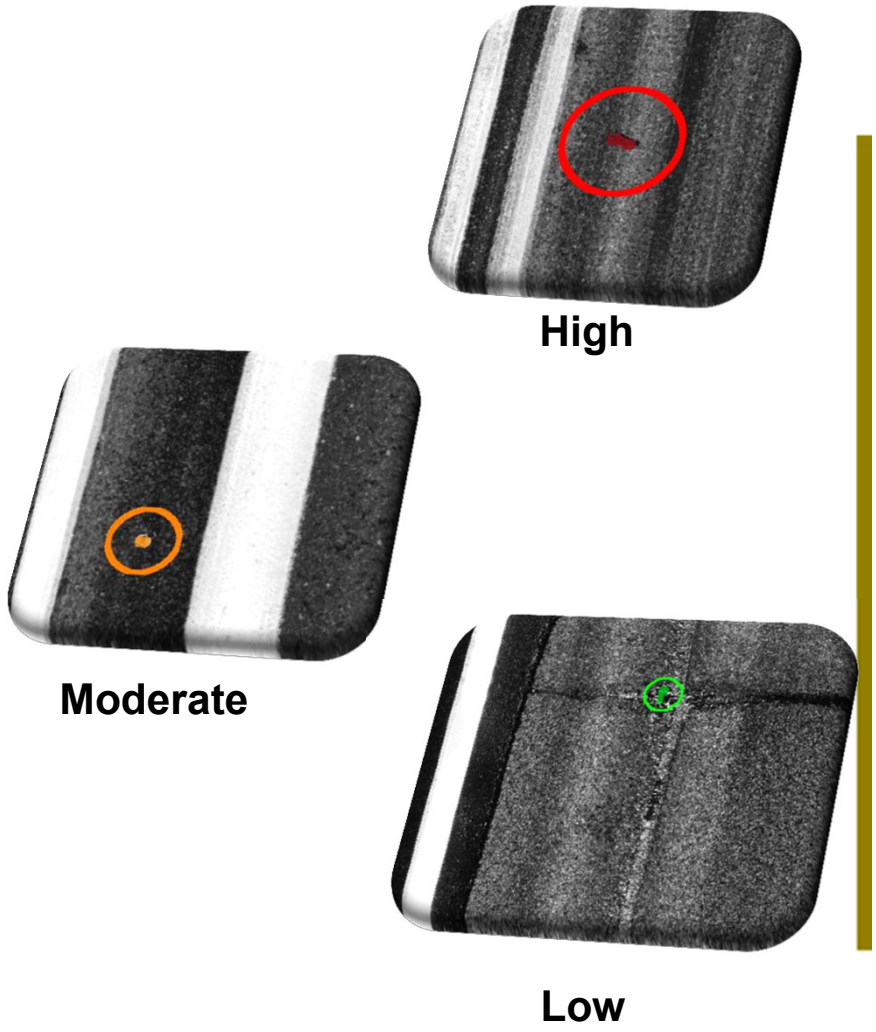


Automatic FOD Detection of Submersed FOD

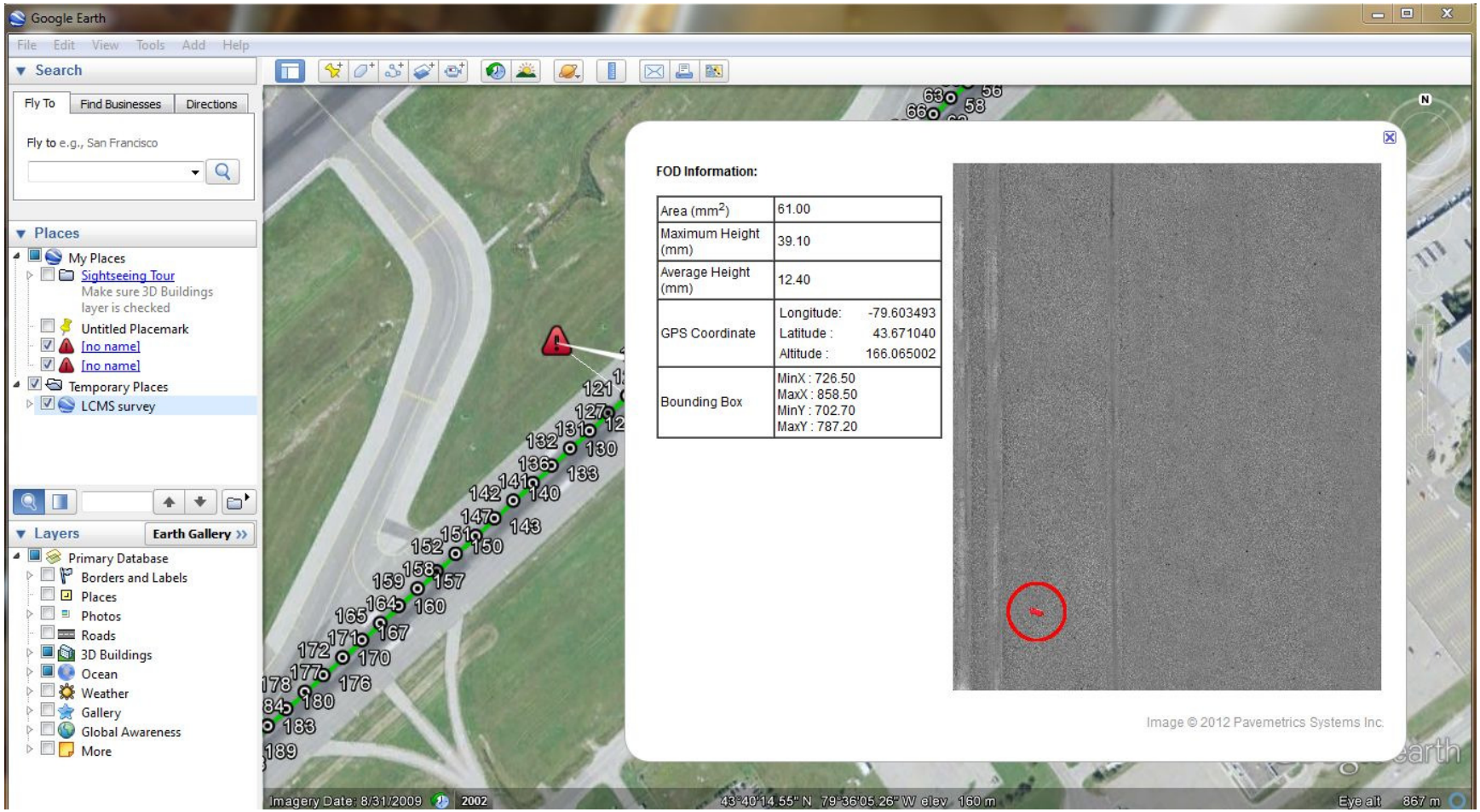


Ability to Group FOD According to Size

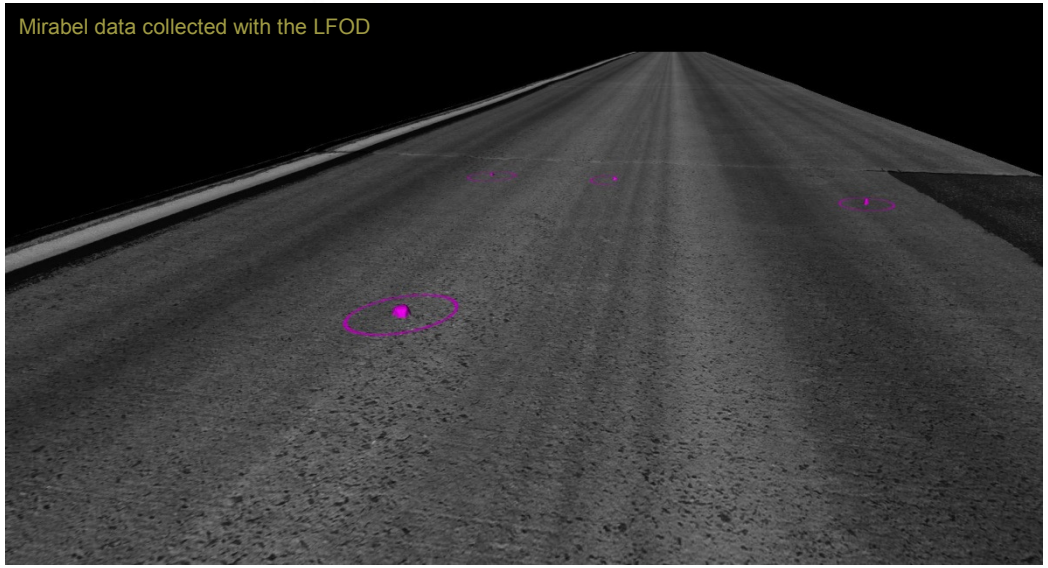
- With greater ability to detect FOD comes the need to reconsider how to react
- Some FOD you will want to stop and immediately collect
- Some FOD you will record details for in order to subsequently deploy sweepers to remove

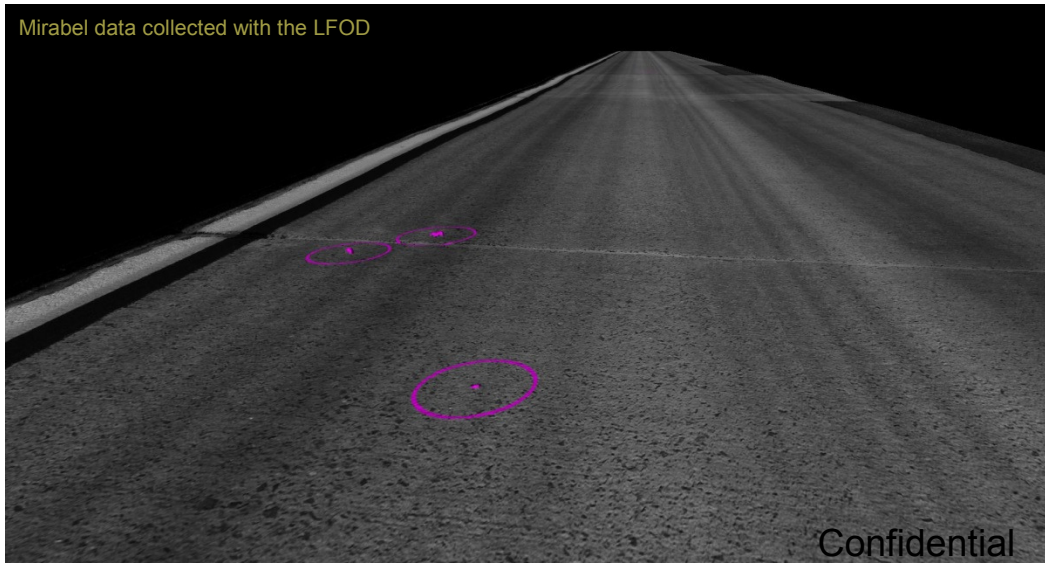


Detected FOD With Range Image



Detected FOD – Mirabel Data





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Thank you!